IN THE SPECIFICATION:

Please change the title as follows:

INK JET PRINTING ~~USING ELONGATED PIXELS~~ METHOD AND PRINTER

Page 1, immediately following the title, please insert the following:

This is the U.S. national phase of International Application No. PCT/GB03/03767 filed September 1, 2003, the entire disclosure of which is incorporated herein by reference.

BACKGROUND OF THE DISCLOSURE

Field of the Disclosure

The paragraph beginning on page 1, line 1 has been changed as follows:

The ~~present invention~~ disclosure relates to printing and, in a particularly important example, to ink jet printheads.

On page 1, after line 2 please insert a heading as follows:

Related Technology

The paragraphs beginning on page 1, line 15 have been changed as follows:

In use of the printhead, failure of even a single nozzle can lead to perceptible print ~~artefacts~~ artifacts, because of the spatial correlation of the ~~artefact~~ artifact as the printed substrate is indexed past the printhead.

SUMMARY OF THE DISCLOSURE

Accordingly, ~~it is an object of the present invention to provide~~ the disclosure provides improved methods of printing and improved printheads that are able to conceal ~~artefacts~~

artifacts arising from nozzle failures or other departures from standard print performance across a print row.

Accordingly, the ~~present invention consists in one aspect in~~ disclosure provides a method of printing parallel rows of contiguous pixels on a substrate indexed in a direction orthogonal to the rows, comprising the steps of printing for each row of pixels N superimposed rows of contiguous super pixels, each print pixel being capable of receiving print contributions from N super pixels, and each super-pixel preferably being elongated in the row direction with an aspect ratio of N:1.

The paragraph beginning on page 2, line 3 has been changed as follows:

Preferably, print data ~~is~~ are received in the form of an array of print data pixels and wherein the value of each super pixel is derived as a weighted sum of preferably at least three corresponding data pixels with each super pixel preferably symmetrically disposed with respect to print data pixels.

In a preferred form ~~of the invention~~, the printability of each super-pixel 10 is measured, and the contribution to those pixels covered by that super-pixel is transferred wholly or in part to one or more other super-pixels from which those pixels are capable of receiving print contributions in accordance with any measured deviation in printability of that super pixel.

The paragraph beginning on page 2, line 18 has been changed as follows:

According to a further aspect, the ~~present invention consists in~~ disclosure provides an ink jet printer having a plurality of ink chambers each provided with a nozzle arrangement, the plurality of ink chambers being arranged so as to print on a substrate a row of contiguous print elements, the nozzle arrangement of each ink chamber being such that the print element

associated with that ink chamber is elongated in the row direction with an aspect ratio of at least 2:1.

The paragraph beginning on page 2, line 31 has been changed as follows:

In still a further aspect, the ~~present invention consists in~~ disclosure provides a method of printing a representation on a print medium of an array of print data pixels comprising the steps of distributing print data from said array of print data pixels over an array of super pixels in a distribution function such that each super pixel receives a print data contribution from at least two print data pixels and each print data pixel contributes print data to at least two super pixels; and forming print pixels on the medium such that each print pixel receives print contribution from at least two super pixels.

The paragraphs beginning on page 3, line 11 have been changed as follows:

Suitably, the method may further ~~comprises~~ comprise the step of measuring the print efficiency of each super pixel, with said distribution function preferably including the measured print efficiency.

In a preferred form of the ~~invention~~ method, the step of forming print pixels on the medium such that each print pixel receives print contribution from at least two super pixels comprises the steps at each print pixel of depositing ink in an amount determined by one of the super pixels from which that print pixel receives print contribution and, ~~whilst~~ while that deposited ink remains fluid, depositing ink in an amount determined by an other of the super pixels from which that print pixel receives print contribution.

In yet a further aspect, the ~~present invention consists in~~ disclosure provides a printer comprising an input port adapted to receive an array of print data pixels; a print arrangement for forming overlapping super pixels on a print medium and a print processor adapted to

distribute print data from said array of print data pixels over the super pixels in a distribution function such that each super pixel receives a print data contribution from at least two print data pixels and each print data pixel contributes print data to at least two super pixels.

On page 3, after line 27 please add a heading as follows:

BRIEF DESCRIPTION OF THE DRAWINGS

The paragraphs beginning on page 3, line 28 have been changed as follows:

The ~~present invention~~ methods and printers will now be described by way of example with reference to accompanying drawings in which:[-]

Figure 1 is a schematic view of an ink jet printhead according to the prior art;

Figure 2 is an end view of an ink jet printer according to one embodiment of the ~~present invention~~ disclosure, with a nozzle plate removed for clarity;

Figure 3 is a sectional side view of an ink jet printer shown in Figure 2;

Figure 4 is a perspective view of an ink jet printer according to another embodiment of the ~~present invention~~ disclosure, with parts removed for clarity;

Figure 5 is schematic view (similar in diagrammatic form to Figure 1) of an ink jet printhead according to an embodiment of the ~~present invention~~ disclosure;

Figures 6 and 7 are diagrams illustrating the alignment of input data pixels, super pixels and pixels printed on a substrate; and

Figure 8 is a diagram illustrating the performance of an ink jet printer according to an embodiment of the ~~present invention~~ disclosure.

On page 4, after line 13 please add a heading as follows:

DETAILED DESCRIPTION

The paragraph beginning on page 4, line 33 has been changed as follows:

If one chamber or nozzle should fail (as marked schematically at X), there will be an unprintable pixel in the print row. Even though the number of ink drops per unit length of the print row may be high (perhaps 360 dpi), a single unprintable pixel may still produce a visually unacceptable ~~artefact~~ artifact because of the spatial correlation of that ~~artefact~~ artifact as the print substrate is indexed relative to the printhead.

The paragraph beginning on page 5, line 17 has been changed as follows:

The print head of Figures 2 and 3 is of a structure commonly known as an "end shooter["]." As is known, for example from EP-A-0 277 703 incorporated herein by reference, channels 10 are formed in a block 32 of piezoelectric material ~~polarised~~ polarized in the direction of arrow 35. The application of a electric field across electrodes 34 formed on opposite surfaces of a side wall 36 causes the piezoelectric material of the side wall to deflect in shear mode, thereby causing the ejection of an ink droplet from a nozzle associated with the channel. The position of the nozzles within the chamber is depicted schematically and may or may not be provided entirely within the channel. It is often possible for a portion of the nozzle to overlap the walls without a significant change in ejection characteristics.

The paragraph beginning on page 5, line 31 has been changed as follows:

The print head of Figure 4 is a structure commonly known as a "side shooter["]." Nozzles 38 are provided within a cover plate 37 and are located at a point which lies between the ends of the channels. There are two nozzles for each channel 10. Ink ports (not shown) are provided at either end of the channel to allow circulation of ink through the ejection

chamber. A print head of this type, but with just a single nozzle is described in WO 91/17051. The nozzles are shown schematically and are not to scale.

The paragraph beginning on page 6, line 19 has been changed as follows:

It is convenient to regard the elongated ink drops 30 and 32 as printing "super-pixels["]," each pixel printed on the substrate receiving contributions from up to two super-pixels. The printed pixel structure is depicted in Figure 5 as units A, B, C, D of line 40. In the control and drive arrangement for the printhead, provision is made to distribute the desired print density for a particular pixel between the two super-pixels which contribute to that pixel. In a typical arrangement, the desired print density for a pixel - established on a suitable greyscale - would be distributed 50% each to the two corresponding super-pixels. In the event that a failure of an ink chamber (or the associated nozzles) is detected, the distribution of print density can be switched so that each of the two pixels covered by the now missing super-pixel receive 100% of the desired print density from the other super-pixel which covers that pixel. This compensation for a missing super-pixel through variation in the greyscale of ~~neighbouring~~ neighboring super-pixels will effect ~~neighbouring~~ neighboring pixels. Such effects will generally be far less noticeable than an unprintable pixel. In an improvement, steps are taken to add noise (either by subtracting or adding grey levels) to distribute the effects of the missing lines over ~~1~~ one or more ~~neighbouring~~ neighboring superpixels and reduce the spatial coherence of the ~~artefact~~ artifact.

The paragraph beginning on page 7, line 20 has been changed as follows:

In one embodiment of this ~~invention~~ disclosure, a print test is conducted to measure the print rate at each super-pixel for a nominal full black print density. This information is then employed in a calibration process which determines during future use of the printhead

how the super-pixel greyscale values S_1, S_2, ... are derived from the input pixel greyscale values P_A, P_B, ...

The paragraph beginning on page 7, line 32 has been changed as follows:

A further approach to derive greyscale levels for the super pixels from the greyscale values received as input print data ~~whilst~~ while correcting for both errors within the print heads and enhancing the edges is as follows:

The paragraph beginning on page 8, line 27 has been changed as follows.

~~It should be noted that an~~ An alternative arrangement can be identified (as shown in Figure 7) in which the array of super pixels is not ~~symeetrically~~ symmetrically aligned with respect to the array of input data pixels.

The paragraph beginning on page 9, line 11 has been changed as follows:

The error in the grey value is at each super pixel (arising from the measured error and the distribution of that error over ~~neighbouring~~ neighboring super pixels) is then calculated from the equation:

The paragraph beginning on page 9, line 19 has been changed as follows:

The print data for each super pixel ~~is~~ are subsequently calculated from the equation:

The paragraph beginning on page 9, line 24 has been changed as follows:

The calculated ~~Print~~ print data ~~is~~ are sent to the ejection channels to print the required image.

The paragraph beginning on page 9, line 32 has been changed as follows:

This described arrangement has a number of advantageous features. If a particular ejection chamber is inoperable (so that the measured error $E_p = 1$), the effect of the error distribution is to increase correspondingly the grey level of those super pixels in the other row that overlap with the "failed" super pixel. There is therefore avoided the highly visible ~~artefact~~ artifact of a straight line of unprintable pixels. This is illustrated diagrammatically in Figure 8.

The paragraph beginning on page 10, line 15 has been changed as follows:

~~It will of course be understood that the~~ The calculations described above represent only one example of a technique for distributing input print values over super pixels. In certain applications, the step of measuring the printability of super pixels may be omitted. In other applications, nonalgebraic techniques may be employed. Also, the distribution may be caused to vary with the input print data, if thought appropriate.

The paragraph beginning on page 11, line 7 has been changed as follows:

In the description of preferred embodiments, the example has been taken of an ink jet printer with N rows of ejection chambers extending (or scanned) across the print medium, with the medium indexed in a direction orthogonal to the row direction after each pass. In an alternative, the super pixels from one pass are superimposed with super pixels from another pass. Care should be taken that N super pixels contribute to each print pixel; this can be achieved - for example by ensuring that all N super pixels are printed ~~whilst~~ while the ink remains wet or (in the case of curable inks) un-cured.